New Progress Achieved by NSFC Project in Basic Research of Black Hole Physics

Supported by NSFC, Prof. Wu Shuangqing from Huazhong Normal University conducted independent research on gravitation theory, discovered the exact solutions for the five-dimensional Gödel charged rotating black hole in the universe, and made important headway in the characteristic research of black hole solutions. Part of the research results has been published in international top journal Physical Review Letters 100, 121301 (2008).

Due to various reasons, the exact solutions for high-dimensional rotation, especially the charged rotating black hole solution, has attracted great attention from people in recent years, but the exact solution of the high-dimensional charged rotating black hole, especially its solution in pure Einstein-Maxwell theory, is still by far very little known.

However, black hole in reality shall be put against the background of our universe while the standard model of universe solution put forward by Friedman-Robertson-Walker is too idealized and can not well describe the running of the universe. In 2003, Gimon and Hashimoto embedded the five-dimensional Kerr black hole into the pure Gödel universe and obtained the Kerr-Gödel black hole solutions, among which Gödel parameter stood for rotation of the universe. This exact solution later attracted great attention and invited further study. However, the Kerr-Gödel charged rotating black hole is still unknown and the traditional method can hardly calculate the quantal conserved charges, such as mass, angular momentum, charge, etc.

Based on the above work, Prof. Wu Shuangqing, with the support of his NSFC project (project no: 10675051), constructed the exact solutions for the five-dimensional Gödel charged rotating black hole in the universe within the framework of Einstein-Maxwell-Chen-Simon minimum super gravitation theory, and conducted comprehensive research on its basic properties, thermodynamic properties and symmetric property. With the application of thermodynamics, he first successfully elaborated the fact that Gödel parameter possessed similar function to cosmological constant.